Satellites and Remotely Piloted Aircraft

Two Remotely Operated Ships Passing in the Fight

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Don't fire until you see the whites of their eyes!

—Col William Prescott
Battle of Bunker (Breed's) Hill, 1775

Combat identification for unmanned aircraft systems (UAS) during time-sensitive targeting can be messy and may include inputs from the distributed common ground/surface system, the combined air and space operations center, the ground commander, and, of course, the UAS pilot.

—Pilot of a remotely piloted aircraft
Operation Enduring Freedom

Advances in technology allow modern forces to fight battles at extreme distances, separating the shooter from the target. Whereas Colonel Prescott delivered his famous directive in person and on the battlefield, the ground commander in Afghanistan communicates with the remotely piloted aircraft (RPA) unit in Nevada while inputs stream in from the distributed common ground/surface system in Virginia and the combined air and space operations center in Qatar.[1] Like RPA operations, space operations are distinguished by vast geographic separation between the ground and (space) vehicle segments. According to Gen Kevin Chilton, commander of US Strategic Command, space operations are "absolutely global in nature and indifferent to physical terrain or lines drawn on a map."[2]

Forces able to distribute their operations geographically can gain advantages in force protection, economy of force, flexibility, and system and personnel costs; however, such distribution also exposes them to unique vulnerabilities and challenges. With the advantages in mind, the military has already fielded many remotely operated systems or has them under development, demonstrating an evolutionary trend toward more, not fewer, distributed operations. The RPA example above is a prolific one in the air domain; examples exist in other physical domains as well. General Chilton has punctuated the growing reliance on distributed operations for the space and cyberspace domains, identifying them both as media "in which the United States can expect to be challenged."[3] In general, fourth-generation warfare theory also supports this trend by suggesting that military operations are more "likely to be widely dispersed and largely undefined."[4]

In light of this relatively new trend, military leaders need to consider potential second-order effects, uniquely associated with distributed capabilities, that may detract from the advantages that these capabilities bring to the fight. Comparing space and RPA operations illuminates several of these effects. By leverag-

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ing the experience gained from decades of space operations, military leaders can translate applicable lessons learned from a relatively mature unmanned community to a comparatively young one. Many of these lessons also apply to remotely operated capabilities in other domains.

Why should we compare space and RPA operations? Of all the terrestrially based remotely operated systems, RPAs currently make up the preponderance of those systems distributed across significant distances—that is, outside the immediate area of responsibility. Operators of other remote systems are in fairly close proximity to the vehicles they control, but those systems may grow more distributed over time; thus, their communities could also benefit from this discussion. Unlike the recent trends in air, land, and sea domains, historically, space operations have always been distributed (and remotely operated) due to the unique physical attributes of, technical challenges peculiar to, and risks in the space domain. As Gen C. Robert Kehler, commander of Air Force Space Command (AFSPC), remarked during a visit last year to Creech AFB, Nevada, home of Air Force RPAs, "We understand remote split operations in AFSPC. We have been operating UASs for many years. It's just that those UASs fly outside the atmosphere, and we fly things that are more than 22,000 miles away. We do that with remote split operations."[5] Military space operations do involve several *manned* weapon systems, especially ground-based platforms performing space-related missions. Examples include launch vehicles, most space situational-awareness sensors, and space-control systems with a direct physical, rather than a remote, connection to the weapon system; however, this article addresses satellites because they represent the preponderance of space operations and are, in essence, remotely operated space vehicles. Satellite system architectures closely resemble RPA architectures since both consist of control segments, vehicle segments, and the links connecting them.

Nevertheless, the crisscrossing evolutions of satellites and RPAs distinguish the two. On the one hand, space operations began in a distributed mode but have grown closer to the fight by deploying new systems and expertise into the theater of operations.[6] RPA operations, on the other hand, distribute key elements of traditional air operations away from the theater. Despite their differences in capability and operating domain, space and RPA operations share enough characteristics to make them worthy of comparison as examples of distributed operations.

Background, Analysis, and Embedded Recommendations

With the space community's more than five decades of experience in distributed operations, what lessons apply to the RPA community? The doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) construct used by the Joint Capabilities Integration and Development System, offers a framework for comparison and analysis.[7] A DOTMLPF analysis of space operations reveals some recommendations that can help remotely operated communities in other domains better prepare for future distributed operations.

Doctrine

Despite the importance of doctrine to military success, especially the effective employment of new technologies, military personnel have noticed a lack of an overall doctrine for RPAs.[8] The uniqueness of these aircraft and other remotely operated systems warrants specific guidance to address shortfalls and differences in existing doctrine.

Current command and control (C2) doctrine posed significant challenges to space operations in the late 1990s and early 2000s as space capabilities became more integrated with traditional military operations.

Most of these hurdles concerned command relationships, more specifically, the best way to present space forces and command and control them during major military operations.

Two nuances, unique to space operations at the time, forced leaders in-theater and in US-based space organizations to reexamine existing C2 doctrine for establishing command relationships. First, space units can create effects within the traditional area of operations without the need to fully deploy or undergo a change of operational control (CHOP) to theater. Second, space capabilities can create effects across the entire area of operations—even across multiple areas of responsibility simultaneously or within the same tactical timeframe (i.e., a single execution cycle for satellite planning, similar to a single Global Hawk sortie).

Traditional criteria for establishing command relationships did not address these nuances, so conflict ensued between supported and supporting commanders over how best to resolve this doctrinal gap. After years of experimentation, exercises, operational experience, and heated exchanges, the Air Force developed specific doctrinal criteria to help commanders establish the appropriate command relationships, such as operational control, tactical control, or a supporting affiliation.[9] Using this doctrine as a baseline, the RPA community should establish exact criteria for defining command relationships when units do not need to fully deploy or when their weapon systems can create simultaneous effects across traditional areas of operations.

Organization

During the past two decades, space expertise and organizations evolved within geographic commands in order to better integrate space capabilities into traditional military operations; advise senior theater leadership on space capabilities; and plan, coordinate, and execute theater space operations. The speed and effectiveness of this evolution depended on the location and organizational affiliation of the space personnel involved.

Initially, very few space-savvy personnel existed outside of US Space Command (USSPACECOM) to assist theater commanders in integrating these new capabilities.[10] Similarly, theater expertise did not flow back into USSPACECOM to help career space officers understand the environment, requirements, and culture of traditional military operations. To remedy this situation, in the mid-1990s USSPACECOM, AFSPC, and their equivalents from other services began deploying space support teams to theater organizations for planning, exercises, and real-world operations. The next step involved creating a permanent presence in major theater headquarters using liaison officers—specifically, officers working side by side with theater leadership but reporting to USSPACECOM or its subordinates. Finally, the Air Force assigned space experts—mostly graduates from the space course at the US Air Force Weapons School—to major theater headquarters, reporting directly to theater commanders. This evolution from deployable teams to liaison officers to permanent-party experts was a key element in increasing the effectiveness of space capabilities as geographic theater commanders gained more influence over space requirements and integration.[11]

While this evolution occurred at the junior-officer level, a similar one occurred at the senior level, although it lagged the junior-level process by several years. Senior space officers served as liaison officers, deployed, and then eventually became permanent members of theater headquarters as directors of space forces (DIRSPACEFOR), positions created to facilitate coordination, integration, and staffing activities in support of space-integration efforts for the combined force air component commander.[12] A critical milestone, establishment of the DIRSPACEFOR position gave space operations a forum and voice in theater headquarters that junior officers could not always provide. It also enabled senior

space leaders to gain direct experience in theater operations.

RPA operations had their roots in theater operations, but the evolution of theater space organizations is noteworthy because it demonstrates a desired end state for expertise in distributed operations. If the RPA community succumbs to the temptation to distribute too much expertise away from the theater, it could find itself in the same situation as the space community in the early 1990s. By keeping sufficient junior- and senior-level RPA experts embedded within theater organizations, rather than relying on liaisons, the RPA community will ensure effective integration of current and future capabilities. Although not examined here, several organizational changes also occurred inside space organizations to better support theater activities.

Training

Distributed operations carry with them the disadvantage of simultaneous authorities exercised over a single unit by both the "organize, train, and equip" chain of command of their military service and the operational chain of their combatant commands. When units do not CHOP into or out of a theater, commanders experience a dilemma in unity of command in that they must fight a war while they train for it. Space operations mitigate this disadvantage by establishing recurring training requirements for line crews and real-world proficiency standards for training and evaluation personnel (as well as unit leadership). Having to perform periodic real-world operations not only keeps instructors and evaluators proficient, but also enables them to help backfill line crews so the crews can interrupt their normal schedule rotation to fulfill monthly training and evaluation obligations. Major system upgrades and procedural changes can also stress the steady-state manpower levels needed to balance training requirements and real-world operations. Manpower needs must account for potential surge capacity for major modifications to the weapon system, procedures, or real-world operations tempo. Policies and requirements put in place by the space community could serve as a baseline for RPA units that must also train while they fight.

Distributed operations offer a key training benefit insofar as recorded data can contribute to better debriefings of individual missions and help train other operators. Unfortunately, the exclusive use of this data can also lead operators to "drink their own bathwater" by learning the wrong lessons in the absence of external perspectives from supporting or supported forces. Collaboration tools and opportunities to visit related locations in person can generate these external perspectives. Funding for site visits, key conferences, and select debriefings will help distributed operators improve their performance; in turn, those operators will educate forward units on the capabilities and limitations of emerging weapon systems. In fact the first real benefits from the evolution of theater space organizations came from educating theater commanders on space capabilities, which also led to increased credibility for the space community.

Materiel and Facilities

Since satellites and RPAs differ widely due to the operational domains involved, materiel considerations worthy of comparison reside mainly in facilities associated with the control segment and communication links. Despite tight cost constraints, requirements for control nodes should include capacity for growth in both size and coordination demands. The ability to surge efficiently beyond routine mission objectives will enable operators to carry out infrequent but complex operations that necessitate crew augmentation, accommodate outreach opportunities without interfering with operations (i.e., hosting tours for external organizations), and integrate unforeseen future capabilities. Expanding part of the system without major redesign represents

another advantage of distributed systems over traditional manned systems.

The role of simulators in distributed operations also enters into a discussion of the materiel element. Control nodes for remotely operated systems depend heavily on computers and data manipulation, making their functionality easier to simulate than manned systems that operate in the physical environment. Simulators for distributed operations can be incredibly realistic, especially for weapon system displays that use text and graphics versus live video or audio feeds. Close synchronization of upgrades between real-world systems and simulators is paramount since both training and operations occur simultaneously.

Finally, effective distributed operations depend upon links to the outside world. These links are important not only for vehicle connectivity and situational awareness but also for operators to feel connected to the mission and the people they support or who support them. Similarly, realistic visualization tools and meaningful collaboration capabilities can amplify contributions made by personnel operating outside the traditional area of operations. Three-dimensional common operational pictures and training tools, along with live video feeds, assist operators in comprehending the environment not physically present around them. Video teleconferencing, live chat, and ample travel opportunities can also build and maintain professional relationships for successful collaboration, allowing operators to understand the nuances and nonverbal communication behind the inputs they receive. Protection of control nodes and links should also occupy a high position on commanders' lists of priorities since they often represent the most vulnerable aspects of the weapon system.

Leadership and Education

The crisscrossing evolutions of the space and RPA communities also produce useful comparisons for overcoming leadership and education challenges associated with distributed operations. Leaders of distributed operations face two significant obstacles—instilling a warrior ethos and motivating personnel who operate away from their "band of brothers" in the war zone. Some of this disconnectedness can even lead to post-traumatic stress disorder among RPA crews involved in lethal operations.[13] Even though space operations do not currently involve lethality, motivated operators with a warfighter mentality are still critical to mission success, especially personnel integrated directly with ongoing military operations. Initially, the RPA community has the benefit of drawing its personnel from manned systems—these individuals bring their deployed experience with them. The challenge lies in sustaining that perspective in their new community while educating the next generation of operators who might not have the benefit of theater experience. Video teleconferencing, instant messaging, and other electronic collaboration methods can go only so far in creating and sustaining a feeling of connectedness with other personnel and weapon systems involved in the operation beyond the immediate control node. The experience is just "not as potent an emotion as being on the battlefield."[14] Distributed operations may yield huge cost savings and reduce risk, but to periodically connect operators with the battlefield, commanders should allocate funding and man-hours for trips to the theater and other distributed elements. Waiting three years for new operators to take on a liaison or embedded RPA position in-theater is too late to benefit the mission during their first operational tour.

Personnel

The military space community grew out of an engineering culture whose early space operators included either officers with technical degrees or technically savvy contractors. In the 1990s, the Air Force transitioned to nontechnical officers and eventually to enlisted personnel as the mainstay of space operations, at the same time keeping con-

tractors involved to balance the loss of technical expertise. Although this move helped operationalize space capabilities and save money, the pendulum had swung too far, diluting experience at the junior and midcareer levels. The Air Force reacted by pushing for more technical, advanced degrees and for specialization within the career field to counter the degradation in technical proficiency. Moreover, the conversion to enlisted personnel cost young officers early opportunities to gain this expertise as part of their professional development. It is difficult to develop senior leaders in a community that offers few opportunities to acquire technical experience at a junior level. (Approximately 75 percent of second-tour space officers served as missileers in their first assignment.)[15]

In summary, the RPA community should not abandon its origins even though technology permits it to do so. Rapidly training new officer accessions or enlisted personnel to operate RPAs may seem attractive, but such policy changes should occur gradually, allowing commanders to identify and resolve second- and third-order effects before drastic corrections become necessary.

Conclusion

Distributed operations offer unique advantages in warfare, but they can also include serious side effects. By examining space operations and applying lessons learned to other distributed operations, military leaders can minimize negative second-order effects and thereby ensure mission success.

Lessons within each DOTMLPF element can prevent the repetition of mistakes when new domains open or when remotely operated systems appear in the existing operational environment. Distributed operations stretch our current understanding of established domains, thus driving the need for unique doctrine and organizational structures. Furthermore, personnel policies, leadership development, and training programs must adapt to incorporate nuances never before encountered in traditional warfare—or at least not encountered to the extent revealed by modern distributed operations. Finally, placing more emphasis on the design of control nodes, perhaps at the expense of some vehicle prominence, will allow leaders to leverage the most versatile and flexible segment of distributed weapon systems.

By taking a hard look at how space operators approached these elements, military leaders can improve the integration, evolution, and mission contributions of newer distributed systems such as RPAs. As space operations evolve toward and RPAs evolve away from their traditional operating environments, they learn many lessons for sharing—like two remotely operated ships passing in the fight. ✪

Vandenberg AFB, California

Notes

1. National Park Service, "Bunker Hill Monument," http://www.nps.gov/bost/historyculture/bhm.htm (accessed 22 September 2009); and Joseph L. Campo, to the author, e-mail, 28 September 2009.

2. Gen Kevin P. Chilton, "Cyberspace Leadership: Towards New Culture, Conduct, and Capabilities," *Air and Space Power Journal* 23, no. 3 (Fall 2009): 5, http://www.airpower.au.af.mil/airchronicles/apj/apj09/fal09/fal09.pdf (accessed 21 May 2010).

3. Ibid., 6.

4. William S. Lind et al., "The Changing Face of War: Into the Fourth Generation," *Marine Corps Gazette* 85, no. 11 (November 2001): 66.

5. Military doctrine does not specifically define *remote split operations*; rather, the term refers to operations described in this paragraph in which the operator and platform are geographically separated from each other. SSgt Alice Moore, "AFSPC Com-

mander Visits UAS Operations at Creech AFB," Schriever Air Force Base, 25 March 2009, http://www.schriever.af.mil/news/story.asp?id=123141399 (accessed 21 May 2010).

6. Maj Keith W. Balts, "The Next Evolution for Theater Space Organizations: Specializing for Space Control," in *Space Power Integration: Perspectives from Space Weapons Officers*, ed. Lt Col Kendall K. Brown (Maxwell AFB, AL: Air University Press, December 2006), 124, http://www.au.af.mil/au/aul/aupress/Books/Brown/brown.pdf (accessed 21 May 2010).

7. Sean C. Sullivan, "Capabilities-Based Planning: Joint Capabilities Integration and Development System and the Functional Capabilities Board," course reading (Newport, RI: Naval War College, 20 August 2008), 4.

8. P. W. Singer, *Wired for War: The Robotics Revolution and Conflict in the Twenty-first Century* (New York: Penguin Press, 2009), 210.

9. Air Force Doctrine Document (AFDD) 2-2, *Space Operations*, 27 November 2006, 10–14, http://www.dtic.mil/doctrine/jel/service_pubs/afdd2_2.pdf (accessed 21 May 2010).

10. Today, USSPACECOM's space-operations mission resides in US Strategic Command.

11. Balts, "Next Evolution," 124.

12. AFDD 2-2, *Space Operations*, 7.

13. Scott Lindlaw, "UAV Operators Suffer War Stress," *Air Force Times*, 8 August 2008, 1, http://www.airforcetimes.com/news/2008/08/ap_remote_stress_080708/ (accessed 9 January 2010).

14. Singer, *Wired for War* (see caption for third unnumbered plate in the photo gallery following p. 308).

15. US Air Force, "13S Career Paths, Deliberate Force Development," briefing, AF/A3O-ST, January 2009, slide 21.